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MEANS FOR THE SCIENTIFIC DEVELOPMENT OF MATHEMATICS TEACHERS[1]

THE war just and justly closing has many lessons for teachers. One of these is that those who are best prepared intellectually and have a deep interest in their subject will win in the end. Pedagogy like militarism trains directly for the object, but knowledge of the subject like the development of the general resources of a country gives real power and endurance. I fear our schools, especially our universities, have lately tended towards the former type of training for teachers and it is hoped that one of the lessons of this war is that there is danger in this direction. Pedagogy, as far as it enables the teacher to make students study what they do not want to study, is the militarism of the teaching profession.

Among the other lessons which this war has taught us as teachers of mathematics is not to lose our confidence in the great usefulness of our subject. If any of us were discouraged during recent years by those who talked thoughtlessly but effectively about the uselessness of algebra and geometry we doubtless have largely recovered from this discouragement. The courses for the Students' Army Training Corps, as well as those given under the auspices of the Y. M. C. A. at the various naval stations, exhibit the extensive mathematical needs of those who aim to render the most efficient service under the most trying circumstances. Our new merchant marine will continue to make large demands for men with considerable mathematical training and will thus tend to emphasize the practical usefulness of our subject.

[1] Prepared for the meeting of the Missouri Mathematics Teachers, which was to be held on November 8, 1918, but was postponed on account of the influenza epidemic.

It is still more important to note the value of mathematical training from the point of view of good citizenship. American lower schools devote much more time to mathematics and other sciences than the corresponding schools of Germany and the "German primary and secondary education is more intensely classical and literary than is British."[2] Mathematics has for centuries been most highly appreciated in France and it has been most thoroughly mastered in the French schools. The account which the French soldiers have given of themselves during the world war is therefore the more inspiring to us as teachers of this wonderful subject.

The mathematics teachers are the mothers of mathematical progress, while the investigators are its fathers. Our teachers' organizations are thus a kind of mothers' clubs where we are inclined to discuss chiefly matters relating to the interests of those committed to our care. The highest devotion implies however, more than self sacrifice. It implies also thoughtful and arduous preparation. In fact, such preparation tends to make our tasks much easier and the things that we can do easily are usually done most efficiently. Hard intellectual work should be done only privately. All such public service should be easy as a result of thorough preparation.

My principal object is to inspire some of you to form a new resolution to strive to grow more rapidly along mathematical lines. The scientific development of teachers is not only a state and national question of paramount importance but it is also of international significance. At the outbreak of the world war its instigator Germany offered several prizes for essays relating to the best ways of using the facilities already at hand and of providing additional facilities for advancing the interests of those engaged in teaching.[3]

The glorious intellectual advances made by American secondary teachers during the last two or three decades is reflected in the rapid transformations of our universities in favor of teachers. These transformations have been so rapid and extensive as to give us little time to reflect upon their bearing and may have advanced already beyond the danger point.

The summer sessions and the summer quarters of our universities have grown rapidly in importance and influence. The universities are enlisting more and more their best talent for teachers during the summer terms instead of allowing their less progressive members to utilize them to increase their salaries.

Secondary teachers can not be urged too strongly to attend these summer sessions whenever they can do so without endangering their health. Teachers of mathematics in particular should aim to take at least one or two courses in the department of pure mathematics, and should not devote themselves too closely to the study of the methods or the history of teaching. The main element of interest about mathematics is the subject itself and the more advanced subjects throw the clearest light on the more elementary parts. In fact, these advanced subjects are only the elementary subjects grown to manhood and we understand the boy better after we have watched him develop into a man. Methods, on the contrary, are simply the outer garments of our subject and no amount of dress will make a skeleton attractive.

A child once watched a robin bearing a worm to its nest filled with little ones stretching out their necks and widely opened mouths in eager expectancy. The mother robin gave little heed to these gaping mouths, and, after resting a few seconds on the edge of her nest, swallowed the worm herself. The child was exasperated and called the mother robin a horrid old thing, but the father of the child directed attention to the fact that if the mother robin would not preserve her strength the helpless little robins would soon have no one to provide for them.

This simple illustration may serve to emphasize the need of looking after our own intellectual sustenance and growth. The help

[2] W. J. Pope, "Science and the Nation," 1917, p. 3.

[3] *Zeitschrift für naturwissenschaftlichen Unterrecht*, Vol. 45, 1914, p. 521.

we can render our students is a function of many variables but among these variables our own knowledge of the subject which we try to teach is doubtless the most significant. Our enthusiasm for the subject is likely to grow with this knowledge and is another important variable upon which our success will depend. It should also be noted that an enthusiam which is expressed only in words is not likely to reach the student's heart.

It is somewhat like the enthusiasm of our pro-German fellow citizens who had a change of tongue immediately after our entrance into the world war. While we were glad to see these changes we were inclined to await a change of mind and still more a change of heart. The change of tongue is the easiest human transformation, then comes a change of mind and finally a change of heart. The enthusiasm coming from the heart of the teacher is the only one which is apt to reach the heart of the student, and if your heart is in your subject you will want to know more about it.

While the summer sessions of our universities offer important facilities for the scientific development of our teachers there are other facilities which are less expensive and more permanent. Among these the high-school library deserves especial emphasis. Books are the cheapest educational factors in the world and most young teachers do not buy enough books relating to their own fields of work. What is more important they do not provide enough mathematical reading matter for their students.

The number of popular mathematical books is not very large, but this number is increasing fairly rapidly, and all high-school students should have access to at least a few of them. A few books on the history of mathematics, on mathematical recreation and on general mathematical expositions should be in every high school library. Such mathematical journals as *School Science and Mathematics* and the *American Mathematical Monthly* should also come regularly to every such library. High school students should be frequently encouraged to read mathematical articles in the genral encyclopedias.

While the books and journals to which we referred should be accessible to the students of every high school, they should especially be used by the teachers, and they afford important facilities for the scientific development of these teachers. Those interested in larger collections and more explicit references should consult "A list of mathematical books for schools and colleges," containing titles of 160 books suitable for the school or college library, which was prepared by the library committee of the Mathematical Association of America, and published in the *American Mathematical Monthly*, volume 24, 1917, page 368.

It should be emphasized that this list of 160 books is for reference and not for intensive study. One of the greatest dangers which beset those of us who are anxious to become strong mathematicians is scientific dissipation. General mathematical reading is extremely useful but the backbone of the equipment of the mathematician is a profound knowledge of a few subjects, and the mastery of a comparatively small number of books. In fact, I believe that if a man would secure a thorough knowledge of certain nine mathematical books beyond a first course in elementary calculus he would be much better informed than the average candidate for the Ph.D. degree.

The mastery of nine volumes does not appear to be an insurmountable barrier between many young teachers of mathematics and the important goal of holding a place in the ranks of the real mathematicians of our land. I take it that there are many here whose views are in accord with the following words of Bacon, printed for years on the covers of the *Mathematical Gazette:* "I hold every man a debtor to his profession, from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and an ornament thereunto."

The nine mathematical books whose mastery, together with a fair amount of general mathematical reading, and a development of some of the thoughts contained in these books, would make us an ornament unto our profession could be selected with considerable latitude.

As one such selection the following may be noted: Weber, "Lehrbuch der Algebra," three volumes; Goursat, "Cours d' analyse mathématique," three volumes; Veblen and Young, "Projective Geometry," two volumes—the second by Veblen alone; Eisenhart, "Differential Geometry," one volume. Those who do not read German might substitute for the three volumes of Weber's algebra the following: Bôcher, "Introduction to Higher Algebra"; Miller, Blichfeldt and Dickson, "Finite Groups"; Ried, "Theory of Algebraic Numbers." Fortunately the first two volumes of Goursat's "Cours" were translated into English by members of the mathematical department of your state university.

It may be noted that this list of nine volumes contains three volumes on each of the three broad fields of mathematics—algebra, analysis and geometry. Moreover, the mastery of these nine volumes would usually be attended by considerable reference work since some subjects are treated therein too concisely for the average student. Unfortunately there exists at present no good mathematical dictionary in any language. It is to be hoped that the Mathematical Association of America will soon remedy this great drawback, especially for the *private* study of mathematics, and it is interesting to note that the chairman of its committee having this matter under consideration belongs to your own state university.

Those who read French and German can not be too strongly advised to provide themselves with the published parts[4] of the large mathematical encyclopedia, whose completion has been so much delayed by the world war. The French edition of this work is especially complete, as far as it has been published, and our chief objection to the list of 160 library books noted above is that it makes no mention of this superior work of reference. Almost equally reprehensible seems to be the omission of the very useful Volume I., "Subject, Index, Pure Mathematics," Royal Society of London Catalogue of Scientific Papers. Every student should have an opportunity to determine the limits of our present knowledge along particular lines which may interest him.

While the careful study of nine such volumes as were noted above would serve as a kind of admission card to the circle of pure mathematicians it is necessary to emphasize the fact that high standing in this circle would imply various other attainments. One of the foremost of these is a comprehensive knowledge of the literature along at least one important line of mathematical work. Such a knowledge could scarcely be acquired without using French, German and Italian literature. Hence a reading knowledge of these languages, especially the first two, is very important for the prospective mathematician. During the last two or three centuries the French have contributed more than any other nation towards the advancement of mathematics.

We have thus far failed to mention what may appear to many as the foremost qualification for a high position in the circle of mathematicians; viz., research ability of high order. It is true that the highest mathematical honors are usually reserved for those who possess this ability in a high degree in addition to the attainments to which we referred. It is, however, equally true that the highest research is usually spontaneous and takes care of itself provided the proper foundations have been laid and the necessary enthusiasm is present.

It is difficult to see how a man with high mathematical attainments and deep mathematical interest can help doing research work. It is the most charming occupation in the world even when the results appear unworthy of publication. When results are reached which seem to be of permanent value and to serve as rays of light to all future generations the investigator naturally experiences feelings of delight that enrich his inner life as few things do.

The view that all mankind has equal mathematical opportunity in this world is not

[4] This publication is not as far advanced as one would naturally infer from a reference thereto recently made by the retiring chairman of the Chicago Section of the American Mathematical Society on the opening page of an address published in volume 25 of its *Bulletin*.

strictly in accord with facts, but it is becoming more and more nearly true. A little more than three and a half centuries ago Robert Recorde, author of the first book in English dealing with algebra, remarked that "My fortune is not so good to have quite tyme to teache." Notwithstanding his valuable services to education he was compelled to spend the last days of his life in prison on account of his debts.

Some of our modern teachers still feel that their fortune is not so good as to give them quiet time to study, and hence they are using their spare time to add to their financial incomes. It is very unfortunate that the so-called "Tangible Rewards of Teaching"[5] are still so meager, but these rewards have steadily increased, especially during recent years. In a large number of cases they are now sufficient to permit complete devotion to the duties of the position and the necessary study for self-development. According to the report mentioned above, page 318, there was at least one school in this state about six years ago which paid its teachers less than fifty cents a day. It is to be hoped that such conditions do not exist to-day.

The alleviation of the mathematics teachers position is, however, more largely due to the improvement in general library facilities and the maintenance of good mathematical periodicals than to improvements in salaries. It is interesting to note that our leading mathematical journal for teachers of the college grade was started in this state, and was maintained for eighteen years (1894–1912) mainly through the sacrifices of one of your college professors. In 1916 it became the official organ of the Mathematical Association of America.

Such periodicals have done much towards establishing closer contact between mathematicians, and are thus giving to people everywhere a large number of the advantages formerly enjoyed only by those living near the great centers of mathematical activity. They have extended the mathematical advantages of Paris to the whole world. It is still too early to comprehend fully the marvelous mathematical transformation due to the advantages of mathematical journals of various grades. This transformation has been gradual and hence it aroused little comment, but it has largely annihilated distances from mathematical centers, and mathematical research of high order may reasonably be expected to become more and more cosmopolitan.

In recent years a new and important opportunity for service has come to the high school teachers of mathematics. Public libraries have increased in a most encouraging way, but useful mathematical literature is frequently very inadequately represented therein. Teachers of mathematics everywhere should help to correct this situation. They should not only supply those in charge with lists of most suitable mathematical books and journals but they should also encourage their own students to use the mathematical facilities offered by these libraries. If I could encourage the teachers of this state to make a strong effort to have mathematical literature properly represented in their local public libraries I should feel amply repaid for coming to this meeting.

Few students can read such an elementary book as "Philosophy and Fun of Algebra," by Mary E. Boole, without getting new light as regards the real meaning of elementary algebra. The student of elementary geometry will not only take great delight in reading such books as E. A. Abbott's "Flatland," but he will also acquire from it new and important notions as regards the nature of geometric dimensions. Mathematical clubs show that general mathematical questions attract many of our ablest young students and it seems reasonable to suppose that this will always remain true.

It is one of the mathematics teacher's great privileges to help to direct the thought of the younger generation towards a subject of sustaining intellectual interest. One of the interesting experiences of my own student life in Paris was to see two gentlemen beyond the age of sixty follow regularly a course of

[5] A bulletin relating to teachers' salaries was published under this title by the U. S. Bureau of Education as *Bulletin*, 1914, No. 16.

lectures given at the Sorbonne by E. Picard. Mathematics is not only for the young and those who make a living therefrom, but its study leads to an intellectual penetration with unlimited room for growth. Our interest in this subject naturally grows with our knowledge thereof and the former is apt to grow much more rapidly than the latter.

In view of these facts it seems to me that all the larger city libraries should contain a considerable collection of modern mathematical works, including current parts of the best modern mathematical reference work, viz., "Encyclopédie des Sciences Mathématiques," so that new parts of this important work may become available soon after their publication. High school teachers of mathematics can render great assistance in this direction by familiarizing themselves with suitable mathematical collections and the needs of their local libraries, and suggesting improvements to the proper authorities.

Above all let us try to instil in our students a desire for more mathematical knowledge, and encourage them to utilize the facilities of local libraries along mathematical lines. Our large general dictionaries and encyclopedias contain much that can be used to advantage during mathematical recitation periods. It is scarcely necessary to say that such outside contact should not take the place of penetration into the subject in hand, but this penetration is more likely to become attractive if broad contact is kept in mind.

It should be noted that many of our best general works of reference are weak along mathematical lines. As an illustration we may note an entirely senseless definition of regular group appearing under the word *group* in the 1917 edition of the "New Standard Dictionary." This definition is as follows: "a transitive group whose order is the same as that of the letter on which it is made." Such weaknesses are, however, not always harmful to the young student since they may serve to promote the important attitude of mind of not accepting statements without study and verification. As another instance of an unreasonable statement which appeared on the first page of a recent publication of the Department of Commerce, U. S. Coast and Geodetic Survey, No. 92, 1918, we cite the following: "It was his regular custom to spend 17 hours per day in study and writing." An almost equivalent statement appears under the name of J. H. Lambert in the ninth edition of the "Encyclopedia Britannica," but fortunately it is not found in the later edition.

As mathematics teachers, and perhaps as teachers in general, our attitude towards salaries is often inconsistent. In choosing this profession we practically say that we are more interested in intellectual matters than in the making of money. On the other hand, many of our members sacrifice intellectual opportunities for a little increase in salary. Positions which offer a reasonable income together with sufficient time and proper facilities for study should not be abandoned in favor of those offering poorer facilities for intellectual growth but a little more salary. School officials should be impressed by the fact that their teachers appreciate advantages for development and that the best teachers can be secured and held only by furnishing advantages for their development, especially in the form of good library facilities.

The great war for justice and democracy should tend to dignify our high calling since it directs so forcibly attention to the facts that it is sometimes necessary to make great sacrifices for the opportunities for higher development and the rights of nations and of individuals do not depend upon their sizes. We as teachers should be especially impressed by the fact that curtailments of rights must be based on other considerations. With the improvement in world ideals as a result of this war there should come a keener appreciation of thorough preparation for the various duties of life. The appointment of an athlete to a chemical position in Washington for which he was wholly unprepared should be regarded as close to treason even if it may have been due to the ignorance of politicians. Thorough preparation for our various duties should be

our motto as teachers and our own practise should convince the world of our sincerity.

We have thus far considered only the existing means for the scientific improvements of mathematics teachers. It may be desirable to consider also possible new means, for our science is one of infinite progress and hence we naturally look for new things. Possibly the new means for scientific development which I shall outline briefly will appear to you as too idealistic, but high ideals are essential for great progress. Hence I venture to propose that high school teachers should be required to give evidence at the end of every seventh year, until they are forty years old, of having made during the preceding seven years scientific progress equivalent to at least one year of university work.

In fact, this might commonly be in the form of a sabbatical year spent in study at some university. In special cases it might be in the form of attendance at summer sessions, or the publication of scientific work. In all cases is should be understood that the proper authorities would go over the records carefully every seventh year and would insist on such progress as a necessary condition for reappointment. If the young teacher does not grow scientifically at least at the rate of one seventh of the normal growth of the university student he does not possess the type of mind that inspires his pupils properly.

While our young university instructors are not formally subjected to such a rule they are practically subject to a more severe scientific test in our better universities by means of a considerable series of grades, such as instructor, associate, assistant professor, associate professor, professor. In the better institutions each higher grade normally implies scientific attainments which are superior to those required for the next lower grade. It is, of course, difficult to enforce high standards in these times of scarcity of teachers, but with the return of peace we may naturally look for greater competition and higher standards.

To meet these higher standards it is not sufficient that we learn more mathematical facts. Mathematical growth is not based so much on the number of facts as on the kind of facts. The facts must be general and far reaching. A formula involving a parameter is more general than a large logarithmic table because the former contains potentially an infinite number of special values while the latter represents only a finite number of such values. It is, however, necessary to exercise care in regard to the use of the word general in mathematics, for, what is often called general is really very special.

If one established theorem includes another it is evidently proper to speak of the former as the more general, but if one undeveloped theory embraces another it is not so clear that the former should always be regarded the more general. It may be that the generality of the principles underlying this theory is too great to permit of much progress. A theory ought to be regarded as general in proportion to its possible development and not in proportion to the generality of the definitions underlying it.

It is evident that such a use of the word general is attended by great difficulties, but it is hard to see how this word can maintain its position of respect in the mathematical literature unless we do make an effort to restrict its use to the potentially larger things. My thought may become clearer if I note the fact that the most general definition of the term group is too broad to serve as the basis of a theory. The most general group theory is therefore of zero extent and will probably always be of this extent. There is a type of definitions which give rise to the most general theory, but it is practically impossible to fix the limitations imposed by such definitions.

As an instance of a tendency to generalize unduly for the pedagogical purposes in elementary mathematics we may refer to one of the oldest among the somewhat complicated mathematical formulas, viz., the *Heron formula* expressing the area of a triangle in terms of its three sides. This formula is found in the majority of our text-books on trigonometry but it is questionable whether it can be regarded as a useful formula for the ordinary

student of trigonometry. It seems easier to solve such a triangle by dividing it into two right triangles and I understand this method is commonly pursued by the engineer. The love for generalization on the part of the teacher seems to have led him in this case to commit a serious pedagogical blunder.

In closing, I desire to urge you to do your own thinking and not to allow yourself to waste energies on the many modern fads appearing under the high sounding term of reform. The very rapid modern transformations have made us unduly vulnerable to the darts of the faddist whose audacity has outstripped that of the mine and oil promoters of the last few decades. A few mines and oil wells have paid handsomely but most of those which have been advertised extensively proved to be disastrous to the too credulous investor. A similar fate has come to those who are too credulous about educational reforms, whether they appear in the form of the function rattle popularized by F. Klein, vocational training, transfer of training, ability tests, or simply the emphasis on methods above knowledge.

As a result of the many wildcat propositions the universities used to avoid pedagogical investments altogether and they used to be fearless in warning the public against investing their hard-earned money in this way. During recent years, however, our American universities have abandoned this policy, under the leadership of Columbia, and have invested heavily in this line of securities. At first they selected the best class only but recently they seem also to invest heavily, again under the leadership of our largest university, in the more doubtful class. This is done even in the graduate schools.

Hence the public has become more and more unwary, and wildcat pedagogical promotions are thriving as never before. The richness of a few reputable pedagogical mines has served to inspire hope as regards others whose only asset is proximity to the former. Hence the grave need of caution at the present time. The educational public would seem to need some public educational commissions similar to those recently inaugurated along financial lines to protect the ever too gullible public. The scientific development securities to which I directed your attention above do not promise the largest returns but they have withstood the severest test of the ages and hence they should be regarded as the soundest of all intellectual investments. Our students need to be trained to enjoy ideals as well as to utilize the real. Mathematics is the ideal science and there is more moving than improving in reforms.

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BANDED STRUCTURES OF THE ADIRONDACK SYENITE-GRANITE SERIES

The syenite-granite series constitutes the greatest bulk of Adirondack rock. It is younger than both the Grenville metamorphosed sedimentary series and the anorthosite, the former especially having been broken up and badly cut to pieces by the syenite-granite intrusion. In mineral composition the range is from syenite rich in microperthite, orthoclase, and hornblende or augite, together with some plagioclase; to granite rich in microperthite, quartz, orthoclase and microcline, together with some plagioclase, hornblende and biotite; to monzonitic and dioritic facies rich in plagioclase, orthoclase, pyroxene and hornblende. Medium grained rocks greatly predominate but there are many variations to fine and coarse grained and even porphyritic facies. Granulation is common, the feldspars especially being most notably crushed. In structure the syenite-granite series exhibits all sorts of variations from non-gneissoid to excessively gneissoid types, with a moderate degree of foliation prevalent. The color of the typical fresh syenite is greenish-gray, while the fresh granite varies from greenish-gray, to light gray, to light red.

In this paper the features of special interest in connection with the syenite-granite series are the comparatively sharp transitions from acidic to basic facies; from greenish-gray or gray to pink or red varieties; from coarser to

finer grained types; from highly gneissoid to very slightly or moderately gneissoid facies; and from notably granulated to only moderately granulated varieties. The effect is to give bands or layers of varying composition, color, granularity, foliation and granulation, yet all clearly belonging to a single rock body. Such bands or layers usually vary in width from an inch to a hundred feet or more, and in length from a few feet or rods to a quarter of a mile. Banded structures of this sort are common throughout the Adirondack region, but it should be made clear that they are by no means universal. Large bodies of syenite or granite are often remarkably uniform and free from any notable variations or banding.

Bands of amphibolite which, in many places, cause the syenite or granite (more especially the latter) to exhibit a very pronounced banded structure are not considered in this paper. These present some puzzling features and data regarding their significance are now being gathered by the writer. Also, distinct inclusions of various types of undoubted Grenville gneisses which, in the form of lenses or layers, in many places produce a banded structure are not discussed except in so far as they throw light upon some banding of the syenite-granite which has resulted from magmatic assimilation of such inclusions.

Of the many hundreds of observed examples of banded structures considered to be essentially the result of magmatic differentiation, a few will be described in order to give a proper conception of the more common and characteristic variations.

On the mountain spurs, respectively one mile northeast and two miles east of Whitehouse (Lake Pleasant quadrangle), there are shown many facies of the syenite-granite series ranging from greenish-gray hornblende syenite and granite syenite to gray and pink granite and coarse, almost prophyritic, granite. Such rocks play back and forth upon each other by sharp transitions repeatedly for a distance of one half of a mile on each mountain spur where the almost barren ledges are conspicuously banded in layers usually from a few feet to a few rods wide and parallel to the foliation. These bands show many diffenences in foliation, granulation and granularity. Variations of this sort are perhaps the most abundant throughout the Adirondacks.

By the road one and one half miles southwest of Long Lake village (Blue Mountain quadrangle) a freshly blasted ledge finely exhibits bands of greenish-gray syenite, granitic syenite, and gray granite. One band of light gray hornblende granite two and one half feet wide passes by insensible gradations into greenish-gray pyroxene syenite on either side. The bands are parallel to the foliation which varies considerably.

A hand specimen taken from a ledge by the lake shore near Adirondack village (Schroon Lake quadrangle) is distinctly foliated and granulated with a pink band especially rich in feldspar adjacent to a band very rich in quartz plus some garnets, these two bands having on either side gray granite consisting of quartz, feldspar, hornblende and some biotite. These very narrow bands, not sharply separated from each other, are parallel to the foliation. In the same quadrangle, one half of a mile north of Moxham pond, granite in a road metal quarry shows notable variations in coarseness of grain often within a foot or two.

The red hornblende granite of the northern portion of the Port Leyden quadrangle often contains bands of gray quartz syenite in subordinate amount parallel to the foliation. Good exposures are by the lower road crossing on Otter creek.

Professor Cushing, describing the granitic syenite of the Long Lake quadrangle, says:

> Much of the rock is alternately green and red, quite quartzose, and a rock distinctly intermediate between syenite and granite, often passing into granite. Much of it is uniformly red, and the rocks range from syenite to granite in composition.[1]

Professor Kemp, in his description of the syenite of the Elizabethtown-Port Henry quadrangles, says:

> The most acidic variety will quite sharply replace it (syenite); and in the same way a very basic variety may come in and constitute the section for 50 or 100 feet or more. Yet while the

[1] N. Y. State Mus. Bul. 115, p. 478.

transition is sharp there is no evidence of separate intrusive masses.[2]

The interbanding of syenite and granite above cited as occurring in the Long Lake and Elizabethtown quadrangles are by Cushing and Kemp, respectively, interpreted as being most likely due to some process of magmatic differentiation. Kemp says that one is not "justified in inferring more than a differentiation of an eruptive mass into layers or portions of contrasted composition." For most cases throughout the Adirondacks, especially the very common occurrence of banded variations like those illustrated in the above examples, the writer agrees with this interpretation since there appears to be no escape from the idea of some sort of differentiation of the magma into layers of varying composition. Transitions between layers range from sharp to very gradual, but in a typical case the whole body of rock is, as Cushing says, "manifestly bound together as a mass of eruptive material arising from a common magma." Whether or not the transitions are sharp, they are always marked by interlocking crystals.

But what were the physical conditions under which the differentiation occurred? Did the differentiation take place before, or after, or during the process of intrusion? The writer ventures to offer some suggestions by way of partial answers to these questions.

M. E. Wilson has discussed the banded gneisses of the Laurentian Highlands of Canada[3] which are essentially very similar to those of the Adirondacks. In his summary Wilson says: "As regards the origin of the folded, banded and foliated structure of the gneisses, it is concluded that these are all genetically related in the Laurentian mountain-building deformation which acted upon the magmatic axil mass during its consolidation" and "that the principal factor in bringing about the heterogeneity of the Laurentian complex was differentiation aided by (orogenic) deformation during its consolidation."

Now, in the main portion of the Adirondack region the banded syenite-granite series shows little, if any, folding due to orogenic pressure, and the foliation is essentially a magmatic flow-structure produced under moderate pressure, that is a pressure little or no greater than that which resulted from the shouldering action of the syenite-granite magma during its intrusion. Reasons for these conclusions are given at some length by the writer in a recent paper.[4] Such being the case, *orogenic* pressure was not a principal factor in the profeature of the whole central belt of Laurentian duction of the banded structures of the Adirondack syenite-granite series. Wilson states that the banding is a very persistent Highland gneisses, but in the Adirondacks the more localized developments of pronounced banded structures strongly oppose the idea that they were produced under general regional or orogenic pressure. The writer believes, therefore, that orogenic pressure has not been a necessary condition for the production of banded gneisses such as those described in this paper.

It may well be conceived, however, that, in those portions of the rising magma where the shouldering pressure was greater, the differentiation into layers of contrasting composition, color, texture and foliation proceeded more readily, while in other (often large) portions of the magma, where the shouldering pressure was relatively slight, the conditions for differentiation into contrasting bands were not so favorable. The influence of pressure in the production of the banding is thus recognized.

It is further believed that the syenite-granite magma rose very slowly and irregularly, and that there was differential magmatic flowage, especially in those portions where the contrasting bands were developing. Many of the bands are not considered to have consolidated simultaneously since alternating bands showing sharp differences in degree of magmatic flow-structure foliation prove that some of the layers were more fluid and continued to flow after adjacent layers were wholly or nearly consolidated. Accordingly, where the banded structures are well developed we may picture not only the slow intrusion of the

[2] N. Y. State Mus. Bull. 138, p. 48.

[3] *Am. Jour. Sci.*, Vol. 36, pp. 109–122.

[4] *Jour. Geol.*, Vol. 24, pp. 587–619.

heterogeneous syenite-granite magma split up into layers, but also differential movements of the layers, at least during late stages of magma solidification. This conception does not, however, preclude the possibility of some differentiation after portions of the magma came to rest, or even before the intrusion began. In fact it is reasonable to suppose that the commonly occurring large-scale, irregular, gradual transitions from granite and granite porphyry to syenite and even diorite may have resulted from differentiation of the syenite-granite magma before, or during an early stage of, the intrusive process.

Another explanation, supported by field evidence, to account for at least some cases of banded structure should be mentioned. Thus at a number of localities gray or greenish-gray basic syenite or even diorite bands occur in the syenite-granite series where dark Grenville gneiss or amphibolite inclusions are also common. Both igneous-looking bands and inclusions lie parallel to the foliation of the country rock. Sometimes the boundaries of the inclusions are very sharp, but in other cases they are not, and plainly more or less fusion of the inclusions has taken place. All stages from thoroughly fused and absorbed inclusions to others where little or no fusion has taken place may be seen. The thoroughly fused inclusions have a distinctly igneous appearance and their boundaries of course merge into the enclosing rock yielding a more or less well developed banded structure. Some typical cases of this kind of magmatic assimilation are described by the writer in a recent paper,[5] and still others in various New York State Museum bulletins by the writer. Of the large number of cases which have come under the writer's observation, nearly all are of very minor extent, and usually such banding is definitely recognizable as having resulted from assimilation rather than pure differentiation. There is no positive evidence that large bodies of the syenite or granite have been appreciably changed in composition due to the incorporation or assimilation of Grenville rocks. Thus, while it seems certain that assimilation has played a minor rôle in the production of banding of the syenite-granite series, the actual quantitative importance of assimilation as compared with differentiation is by no means definitely known.

WILLIAM J. MILLER
SMITH COLLEGE

[5] *Geol. Soc. Amer. Bull.*, Vol. 25, pp. 254–260.

PROCEEDINGS AND RESOLUTIONS OF THE THIRD RESUSCITATION COMMISSION[1]

THE Commission met in New York at the Rockefeller Institute on Friday, May 17, 1918. There were present at the meeting: Passed Assistant Surgeon E. F. DuBois, U. S. N. R. F., of the Bureau of Medicine and Surgery, Navy Department; Dr. D. L. Edsall, professor of medicine and dean, Harvard Medical School; Mr. W. C. L. Eglin, chairman of committee on safety rules and accident prevention of the N. E. L. A.; Dr. Yandell Henderson, professor of physiology, Yale University and consulting physiologist of the Bureau of Mines; Dr. Wm. H. Howell, professor of physiology and assistant director of the school of hygiene and public health, Johns Hopkins University, member of the National Academy of Sciences; Dr. Reid Hunt, professor of pharmacology, Harvard Medical School, Secretary of Commission; Professor A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology; Dr. Charles A. Lauffer, medical director of the Westinghouse Electric Co., Pittsburgh, Pa.; Dr. S. J. Meltzer, Rockefeller Institute, chairman of the commission, member of the National Academy of Sciences; Dr. Joseph Schereschewsky, Assistant Surgeon General, U. S. Public Health Service; Dr. G. N. Stewart, professor of experimental medicine, Western Reserve University, Cleveland; Professor Elihu Thomson, General Electric Co., West Lynn, Mass., member of the National Academy of Sciences; Lieutenant Colonel Edward B. Vedder, of the Army Medical

[1] Held under the auspices of the Committee on Safety Rules and Accident Prevention of the National Electric Light Association. Edited by Professors Howell, Stewart and Thomson.

School; Major Frank G. Young, of the Ordnance Division of the War Department.

A telegram was received from Surgeon-General Gorgas that Dr. Charles H. Frazier, professor of surgery, University of Pennsylvania, is to represent his office. (In a subsequent communication Major Frazier accepted his appointment.) Conferees: Mr. P. H. Bartlett, Philadelphia Electric Company; Mr. Wills Maclachlan, Electrical Employers Association, Toronto, Canada; Mr. C. B. Scott, chairman of the sub-committee on accident prevention N. E. L. A.; Dr. F. E. Schubmehl, General Electric Co., West Lynn, Mass.

The object of the commission, the chairman stated, is to consider efficient methods of artificial respiration in emergency cases, *as they are met with in peace as well as in war.* For more than a century, England has had several life-saving societies, and many special commissions have been appointed to investigate the methods employed in resuscitation. In this country, about six years ago, a commission on resuscitation from electric shock was created for the first time, by the initiative of the National Electric Light Association. It is now generally recognized that efficient artificial respiration is, for such conditions, the best and practically the only means available for resuscitation. It requires but little consideration to realize that the need for an efficient means of artificial respiration is very wide-spread.[2] The committee on safety rules and accident prevention of the N. E. L. A., of which Mr. Eglin is the chairman, agreed that *the Third Resuscitation Commission should consider its problems from a general point of view.*

Mechanical Methods.—Dr. Meltzer demonstrated in the laboratory for physiology and pharmacology, the efficiency of the method of pharyngeal insufflation in an etherized dog after complete removal of the anterior wall of the thorax, in which the lungs and heart were exposed to full view.

Dr. Rossiter, of the Carnegie Steel Company, demonstrated the latest device of the Pulmotor Company, which is not identical with the original pulmotor. He showed also the original pulmotor. He stated that he had resuscitated eight gas cases, in which the respiration had stopped. This was done by the original pulmotor, in which he had more confidence.

Dr. James M. Booher, medical director of the Life Saving Devices Co., demonstrated the lungmotor. He showed a number of blood-pressure tracings, taken from animals which had received artificial respiration by means of this apparatus. In reply to a question, Dr. Booher stated that in these experiments the lungmotor was connected with the animal by means of a tracheal cannula. (In human cases the lungmotor is applied by means of a face mask.) Dr. Booher left with the commission histories of a number of cases in which the lungmotor had been used. (The commision found no time to examine these written histories, but Dr. Booher mentioned verbally especially two cases. One of these cases was subsequently investigated by the chairman. The life of a poliomyelitis patient with complete paralysis of the respiration was maintained for thirty-six hours by means of the lungmotor. The reporting physician is of very good standing.)

In introducing Mr. Foregger, the chairman explained that the physician who was most competent to present the details of the apparatus of the Foregger Company is now in France. The apparatus consists in modifications of the insufflation apparatus of Meltzer. Among other changes, the apparatus carried an oxygen generator tank. In reply to a question, Mr. Foregger stated that the oxygen thus generated may last eight or ten minutes.

[2] For instance, in injuries to the head which stop respiration, injuries to the chest (especially double pneumothorax) in laparotomies during which the respiration ceases occasionally, in cases of shock which occur in peace and more so in the present war, in poliomyelitis with stoppage of respiration, in post-diphtheretic paralysis, in poisoning by opiates, by volatile gases (ether, chloroform, etc.) by mine and fuel gases, poisoning by magnesium salts, in electric shock and in drowning.

Manual Methods.—Mr. Eglin read a letter from Mr. M. W. Alexander, of the General Electrical Co., stating that he hoped the "commission would be very definite in recommending the prone-pressure method, as experience has proved its value."

Mr. C. B. Scott stated that the accident prevention committee of the N. E. L. A. had reached the point in its investigation where it felt that the prone-pressure method was best to recommend, bearing in mind that machines are not always available in emergencies. His own company had had nine successful cases of resuscitation by the prone method and three unsuccessful cases in which mechanical means were used.

Dr. Schubmehl stated that the prone-pressure method has been most successfully applied by their two hundred and twenty-five first-aid men.

Mr. Maclachlan stated that he had the duty of training possibly three thousand men in the prone method. Their system required the men to practise this method at least once a month. The men are instructed not to desist in less than three and a half hours, and that not till then should they listen to advice from a physician who might tell the operator that the patient was dead.

The secretary read the following parts of a letter from Professor Schäfer, of Edinburgh, to the chairman: "The prone method has been adopted *exclusively* for about twelve years by the Royal Life Saving Society, the only important organization in the British Empire whose object is the resuscitation of the apparently drowned. It has also been adopted for several years by the London and other Police Force, by the Board of Trade, by the Army and the Navy." "The most important thing is in cases of drowning to have something ready which any man can use; which will effect respiratory exchange—whether exactly as much as normal, matters very little."

RESOLUTIONS ADOPTED BY THE COMMISSION

In the discussion following the presentation of methods and evidence to the commission the following important facts were emphasized:

1. That in most accident cases no resuscitation apparatus is at hand for immediate use.

2. That reliance upon the use of special apparatus diminishes greatly the tendency to train persons in the manual methods and discourages the prompt and persevering use of such methods.

3. That police officers or physicians often interfere with the proper execution of manual methods, in that they direct that the patient be removed in an ambulance to some hospital, thus interrupting the continuance of artificial respiration.

4. That in many hospitals the members of the staff are not all acquainted with the methods of artificial respiration.

5. That in medical schools instruction is not properly provided for students in the manual methods of artificial respiration.

In view of these facts the following resolutions were adopted by the commission:

1. The prone-pressure or Schäfer method of resuscitation is preferable to any of the other manual methods.

2. Medical schools, hospitals, fire and police departments, the Army and Navy, first aid associations, and industrial establishments in general, should be urged to give instruction in the use of the prone-pressure method of resuscitation.

3. Individuals who, from accident or any other cause, are in need of artificial respiration, should be given manual treatment by the prone-pressure method immediately on the spot where they are found. It is all important that this aid be rendered at once. The delay incident to removal to a hospital or elsewhere may be fatal, and is justifiable only where there is no one at hand competent to give artificial respiration. If complications exist or arise, which require hospital treatment, artificial respiration should be maintained in transit, and after arrival at the hospital, until spontaneous respirations begin.

4. Persons receiving artificial respiration should, as much as possible, be kept warm and the artificial respiration should be maintained till spontaneous breathing has been permanently restored, or as long as signs of life are present. Even in cases where there is no sign of returning animation, artificial respiration should be kept up for an hour or more.

5. A brief return of spontaneous respiration is not a certain indication for terminating the treatment. Not infrequently the patient after a temporary recovery of respiration stops breathing again. The patient must be watched and if normal breath-

ing stops, the artificial respiration should be resumed at once.

6. Artificial respiration is required only when natural respiration has ceased. In cases of simple unconsciousness from any cause in which natural respiration continues, artificial respiration should not be employed without medical advice.

7. The commission recommends that in cases of gas asphyxiation, artificial respiration, whether given by a manual method or by special apparatus, should be combined when possible with the inhalation of oxygen from properly constructed apparatus.

8. With regard to the employment of mechanical devices for artificial respiration the commission feels that it ought not at present to take a definite stand either for or against any particular form of apparatus. However, the commission recommends, that the use and installation of apparatus should be confined, for the present, to properly equipped institutions under medical direction. The commission recognizes the great need of simple devices capable of performing artificial respiration reliably and efficiently. It therefore recommends careful study of the problem, directed toward *the development of a reliable method appropriate for general adoption.*[3] Such studies can best be carried on in properly equipped hospitals and laboratories which offer opportunities and facilities for critical observation and experimentation.

In view of the importance which the knowledge of proper methods of resuscitation possesses for public health and safety, and considering the fact that many practitioners, members of hospital staffs and graduates of medicine are not thoroughly familiar with the methods of resuscitation, especially that of the prone-pressure method, the commission recommends:

(*a*) That medical journals (and other scientific and practical journals which are interested in the problem of resuscitation) be asked to publish the resolutions adopted by the commission.

(*b*) That a copy of these resolutions be sent to the medical colleges with a request that proper instruction in this subject shall be arranged for in the *College Schedules.*

(*c*) That these resolutions be sent to as many hospitals as possible, with the recommendations that members of the house staff shall familiarize themselves with the methods of resuscitation.

[3] See Appendix.

(*d*) In order that the resolutions of the commission may be brought to the attention of interested circles (fire and police departments, industrial plants, etc.) it was agreed that they be communicated to the Associated Press (by the National Electric Light Association).

It was voted that the Third Resuscitation Commission should be properly organized and continue its existence, ready to respond when requirements arise. The following officers were elected:

President—Dr. S. J. Meltzer.
Vice-president—Dr. Yandell Henderson.
Secretary—Dr. Reid Hunt.
Treasurer—Mr. W. C. L. Eglin.

It was voted to appoint a committee for the collection of verifiable data relating to resuscitation. The president appointed to the committee—

Dr. D. Edsall—Chairman,
Dr. Reid Hunt—Secretary,
Professor Elihu Thomson, and the President Ex-officio.

APPENDIX

The commission consists of fifteen members. Fourteen approved the foregoing report without qualifications. The fifteenth member wishes to qualify his vote by the following

Statement

Dr. Yandell Henderson qualifies his support of the resolutions as follows:

While I concur in a considerable part of the report of the Resuscitation Commission I dissent from the statement in Resolution 8 recognizing "the great need of simple devices capable of performing artificial respiration reliably and efficiently."

Devices which are excellent from the mechanical standpoint are now available and widely sold; but the evidence regarding them indicates clearly, I believe, that even if these devices were on the spot where several gassings or electrocutions occurred, and if all the victims were treated with them, except one who was given manual (prone pressure) treatment, this one would have much the best chance of recovery. In actual practise the apparatus is seldom right on the spot adjusted and ready. Critical time is lost, and thus in the above suppositious cases, as they actually occur, the only victim with any considerable chance of resuscita-

tion (aside from those who recover spontaneously and are credited to the apparatus) is the one treated manually.

Even more important is the fact, demonstrated now by universal experience, that when apparatus is known to be obtainable, it is sent for and the manual method neglected. Thus to-day the apparatus in public use is on the whole contributing very materially to decrease the saving of life.

SCIENTIFIC EVENTS

PROTECTION GIVEN MIGRATORY BIRDS BY AMENDMENTS TO THE BIRD-TREATY ACT

THE United States Department of Agriculture announces the promulgation of amendments and additions to the Migratory Bird-Treaty Act Regulations effective October 25, 1918.

Hereafter the open season for black-bellied and golden plovers and greater and lesser yellowlegs in Texas will be from September 1 to December 15. Another change prescribes a daily bag limit of 50 sora to a person in addition to the bag limit of not to exceed 25 for other rails, coots and gallinules.

An amendment of Regulation No. 6 has the effect of removing the limitation on the number of birds that may be transported within a state during the federal open season. The export of migratory game birds is limited to two days' bag limit during any one calendar week of the federal season. Persons must comply with state laws further restricting the shipment or transportation of migratory birds.

An amendment to paragraph 2 of Regulation No. 8, which is of great interest to breeders of game, permits migratory water fowl raised in domestication to be killed by shooting during the respective open seasons for waterfowl, and the sale thereof to state laws; but after March 31, 1919, such waterfowl, killed by shooting, can not be sold or purchased unless each bird, before attaining the age of 4 weeks, shall have had removed from the web of one foot a portion thereof in the form of a "V" large enough to make a permanent well-defined mark, which shall be sufficient to identify it as a bird raised in domestication.

Another amendment provides that the plumage and skins of migratory game birds legally killed may be possessed and transported without a federal permit. Provision is also made for the issuance of special permits authorizing taxidermists to possess, buy, sell and transport migratory birds.

Two new regulations have been added. Regulation No. 11 provides for the issuance of permits authorizing persons to sell migratory game birds lawfully killed and by them lawfully held in cold storage on July 31, 1918. Such birds may be sold under permit until March 31, 1919.

Another new regulation is as follows:

> Nothing in these regulations shall be construed to permit the taking, possession, sale, purchase or transportation of migratory birds, their nests and eggs contrary to the laws and regulations of any state, territory or district made for the purpose of giving further protection to migratory birds, their nests and eggs when such laws and regulations are not inconsistent with the convention between the United States and Great Britain for the protection of migratory birds concluded August 16, 1916, or the migratory bird treaty act, and do not extend the open seasons for such birds beyond the dates prescribed by these regulations.

This regulation is a restatement of the substance of section 7 of the migratory bird-treaty act, and is intended to remove the confusion and uncertainty that exists in regard to the effect of the federal law and regulations on state game laws.

The federal migratory bird-treaty act regulations prohibit throughout the United States the killing at any time of the following birds: Band-tailed pigeon; common ground doves and scaled doves; little brown, sandhill and whooping cranes; wood duck, swans; curlews, willet, upland plover, and all shore birds (except the black-bellied and golden plovers, Wilson snipe or jacksnipe, woodcock and the greater and lesser yellowlegs); bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grossbeaks, humming birds, kinglets, martins, meadow larks, nighthawks or bull-bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whip-poor-wills, woodpeckers and wrens, and all other perching birds which feed entirely or chiefly on insects; and also auks, auklets, bitterns, fulmars, gannets, grebes, guillemots,

gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters and terns.

POTTERY PRODUCTS

The makers of pottery in the United States reported another record-breaking year in 1917 in value of output, which was $56,162,522, an increase of $7,945,280, or more than 16 per cent. over the value in 1916, according to figures compiled under the direction of Jefferson Middleton, of the United States Geological Survey, Department of the Interior.

The imports of pottery during the year were necessarily small, and the demand was fully equal to the largest domestic supply that would have been produced under normal codnditions, but the American potters found it impossible to supply the demand. Though the value of the output was the largest yet recorded, the volume of the product was probably not so large as it had been in some other years. Few plants, if any, ran to capacity, and many of them did not market more than three fourths of their normal output. The increased cost of labor and raw materials made it necessary to fix higher prices for the wares than those that have prevailed in the last few years. The imports showed an increase over those of 1916 but were much below normal imports before the war. This increase was due chiefly to greater imports from Japan, whose wares are now finding a larger market in the United States.

Notwithstanding the handicaps which the pottery industry suffered in 1917, greater efforts were made to place the industry on a firmer foundation than ever. Realizing that after the war he will have the keenest competition, and knowing that in order to hold his present trade he must not only make ware of superior quality but must be able to undersell all foreign competitors, the American potter has begun to study not only how to improve the quality of his wares but to find or devise labor-saving machines and improved kilns. The report of the United States Potters' Association shows that a number of such devices that give promise of lowering the cost of labor and fuel were introduced in 1917 or were being successfully developed. Among these devices are sagger-making machines, a conveyer type of stove, a casting process that makes large production possible by unskilled labor, and down-draft and tunnel kilns that insure a large saving of fuel.

The effort to establish in the southern states a pottery for the manufacture of high-grade ware has, after many years, at last been successful. In 1917, for the first time, white ware was manufactured in the south. The Southern Potteries (Inc.), began to operate at Erwin, Tenn., a 10-kiln plant for the manufacture of semi-vitreous porcelain table ware, using domestic clays exclusively.

Another important development in the pottery industry of the United States is the production of chemical porcelain, the manufacture of which in this country was considered impossible before the war. Several operators are now making chemical porcelain which satisfactorily meets the exacting requirements of the laboratory.

In 1917 the value of the output of every variety of pottery classified by the Geological Survey, except red earthenware, was greater than in 1916. White ware showed the largest increase—$2,729,079, or 15 per cent. Porcelain electrical supplies also showed a large increase —$2,417,166, or 34 per cent. China, the highest grade of pottery, has been a minor product in value, yet its value in 1917 showed an increase of $1,327,534, or 38 per cent., compared with 1916. Its value in 1917 was nearly twice as great as in 1913.

The value of white ware, including china, which comprises the general household wares and constitutes more than 45 per cent. of the value of all pottery, was $25,726,375 in 1917, an increase of $4,056,613, or 19 per cent., over 1916. If to this sum is added the value of the high-grade products sanitary ware and porcelain electrical supplies, the total value in 1917 was $47,814,178, or $7,998,579 more than in 1916.

THE NATIONAL ACADEMY OF SCIENCES

THE scientific program at the recent Baltimore meeting was as follows:

Cloud reflection and the albedo of the earth and Venus. C. G. Abbot.

Colorimetry of white surfaces. A. H. Pfund, introduced by J. S. Ames.

The inorganic constituents of lobster shells. F. W. Clarke and G. Steiger.

Hydrocephalus. Experimental and clinical study. W. E. Dandy, introduced by W. S. Halsted.

Clinical and experimental observations in cases of arterio-venous and lymphatico-venous fistulæ. W. S. Halsted

Quantitative relations between chromatin and cytoplasm in the genus *Arcella*, with their relations to external characters. R. W. Hegner, introduced by H. S. Jennings.

The physiological effects of air-concussion. D. R. Hooker.

Two new factors in blood-coagulation. W. H. Howell.

Is the arrangement of the genes in the chromosome linear? W. E. Castle.

Cause of phyllomania in *Begonia*. E. F. Smith.

Comparative morbidity of white and colored troops. Chas. B. Davenport and Albert G. Love.

Second report on researches on the chemical and mineralogical composition of meteorites (illustrated). George P. Merrill.

Theory of wind instruments; The ballistic resistance function; The dynamics of the rifle fired from the shoulder. A. G. Webster.

Biographical sketch of George Davidson. W. W. Campbell. (By title.)

SCIENTIFIC NOTES AND NEWS

IN addition to the national scientific societies announced in SCIENCE last week as meeting in affiliation with the American Association for the Advancement of Science at Baltimore during convocation week, the Society of American Bacteriologists will meet on Friday and Saturday, December 27 and 28. The president is Dr. R. C. Buchanan, and the secretary, Dr. A. Parker Hitchens, Army Medical School, 462 Louisiana Ave., Washington, D. C.

IN view of the changed conditions after the armistice, the council of the American Psychological Association has decided to reconsider the postponement of the annual meeting. It has now been definitely planned to have a brief and rather informal meeting upon war topics on December 27 and 28, at Baltimore. A detailed announcement will be sent to members shortly.

THE Inter-Allied Scientific Conference after its meeting in London under the auspices of the Royal Society adjourned to Paris where it continued at the end of November its meetings under the auspices of the Academy of Sciences. The American delegates are: Dr. H. A. Bumstead, Colonel J. J. Carty, Professor W. F. Durand, Dr. Simon Flexner, Dr. George E. Hale, and Professor A. A. Noyes.

AT a recent meeting of the New York branch of the American Chemical Society held at the Chemists' Club, resolutions were passed proposing the organization of an American Chemical Institute under the auspices of the American Chemical Society, whose special function shall be to promote research with a view to the introduction of new or improved medicinal products, so as to make the United States free of any future effort to control this field by German manufacturers.

SENATOR ROBERT S. BROOKINGS, of Missouri, has been named by the Senate to be a regent of the Smithsonian Institution to succeed the late Charles W. Fairbanks.

WITH the rank of Lieutenant Colonel, Dr. William Pepper, Dean of the University of Pennsylvania Medical School, has been reassigned to work at Fort Oglethorpe, Georgia.

DR. GEORGE A. BAITSELL, assistant professor of biology in Yale University, has been granted leave of absence to accept an appointment as captain in the Chemical Warfare Service, United States Army.

DR. M. F. BARRUS, of the department of plant pathology at Cornell University, has recently been commissioned first lieutenant in the Quartermaster's Corps. He will be engaged in the crop production work of the army.

DR. A. G. MCCALL, in charge of the soil investigational work of the Maryland Experiment Station, has been selected by the army

overseas educational commission to take charge of the soils and fertilizer work in France during the demobilization period. Dr. McCall will arrange to continue his work for the National Research Council on the salt nutrient requirements for plants.

Dr. George T. Moore, director of the Missouri Botanical Garden, has been appointed director of the productions division of the United States Food Administration for St. Louis.

Professor Dan Otis, assistant dean of agriculture in the University of Wisconsin, has received an appointment from the government as farm management specialist for France.

Dr. Reginald A. Daly, Sturgis-Hooper professor of geology at Harvard, is a member of the committee which will have charge of the courses of instruction to be maintained in Europe for United States soldiers until they return to this country.

Major R. W. Brock, of the University of British Columbia, has been appointed geological adviser to the British Army in Palestine. For the last two years he has been overseas on military duty.

Mr. Wm. B. Brierley, of the pathological laboratory, Royal Botanical Garden, Kew, and formerly lecturer in economic botany to Manchester University, has accepted the appointment of mycologist to the new Institute of Phytopathological Research, Rothamsted Experimental Station, Harpenden.

At Cambridge the Gedge prize for original observations in physiology has been awarded to Mr. Thomas Richard Parsons, B.A., of Sidney Sussex College, formerly of Birkbeck College, for an essay on "The reaction of blood in the body."

During his stay in England as the representative of the United States Public Health Service, Professor Frederic S. Lee has been asked to sit on the industrial fatigue research board, a newly organized body under the chairmanship of Professor Sherrington. The board will continue in part the activities begun by the health of munition workers committee, which has ceased to exist.

Professor Anton Julius Carlson, chairman of the department of physiology at the University of Chicago, now captain in the Sanitary Corps, is reported to have landed in France at the end of October, after several months of service in connection with the rationing of American troops at the rest camps and in the aviation squadrons throughout England.

Professors James F. Kemp, Waldemar Lindgren, Joseph Barrell and A. C. Lawson, have been at Bingham, Utah, preparing evidence in connection with mining litigation.

Professor J. H. Lahee has resigned from the Massachusetts Institute of Technology to become geologist for the Sun Oil Company in Dallas, Texas.

H. W. Turner has recently made a geological reconnaissance of the Peace River oil field in northern Alberta.

Miss Mary J. Hogue, formerly a member of the zoological staff of Wellesley College, is working in the laboratory of the Base Hospital at Fort Sill, Oklahoma.

Mr. George W. Morey, of the geophysical laboratory of the Carnegie Institution, has been given a year's leave of absence and is in charge of the optical glass plant of the Spencer Lens Company at Hamburg, New York.

Professor Bailey Willis, of Stanford University, recently addressed the New York Academy of Sciences on "The physical basis of national development."

Professor Henry C. Sherman, of Columbia University, lectured before the New Brunswick Scientific Society, on November 25, on "Permanent gains from the food conservation movement."

A joint meeting of the New York Section of the American Chemical Society, the New York Section of the American Electro-chemical Society, the Society of Chemical Industry and the Société de Chimie Industrielle was held on Friday evening, December 6, in Rumford Hall. The program of the evening consisted of the following addresses, accompanied by lantern slides: Colonel William H. Walker,

Chemical Warfare Service, "The manufacture and use of toxic gases;" Colonel Bradley Dewey, Chemical Warfare Service, "The manufacture of gas defense apparatus."

DR. ETIENNE BURNET, of the Pasteur Institute, Paris, surgeon in the French army and member of the Mission of French Scholars to the United States, delivered a lecture at the New York Academy of Medicine in cooperation with Columbia University, November 15, on "Pasteur as a representative of the French scientific spirit."

A RECENT meeting of the Biological Club of the University of Chicago in memory of Samuel Wendell Williston, former professor of paleontology in the university, Dr. Stuart Weller, of the same department, gave an appreciation of Dr. Williston's work. A Williston memorial meeting will be held in Leon Mandel Assembly Hall on December 8, the speakers being Professor E. C. Case, of the University of Michigan, and Professors Stuart Weller and Frank R. Lillie, of the University of Chicago.

PROFESSOR GEORGE F. ATKINSON, head of the department of botany at Cornell University since 1896, died suddenly on November 14, at the City Hospital in Tacoma, Wash. Professor Atkinson was engaged in a field study of the mushroom flora of the Pacific coast at the time of his death.

DR. PIERRE DE PEYSTER RICKETTS, for thirty-two years connected with the teaching staff of Columbia University, died on November 20 at his home in New York City. He was born in Brooklyn seventy years ago, was graduated from the School of Mines, Columbia, in 1871, and received his degree of Ph.D. five years later. He was assistant in the School of Mines for a number of years prior to 1885, when he was appointed professor of assaying, and in 1893 was made professor of analytical chemistry and assaying, retiring in 1900 to become the head of the firm of Ricketts, Inc., mineralogical and mining consulting engineers.

A PERMANENT reserve force upon which the Public Health Service can draw in time of emergency such as that presented by the influenza epidemic has been authorized by the Congress. This consists of officers, none holding rank above that of assistant surgeon general, commissioned by the president for a period of five years, subject to call to active duty by the Surgeon General U. S. P. H. S. When in such active duty they receive the same pay and allowances as are now provided by law for the regular commissioned medical officers in the service. By far the larger part of the reserve to be organized under this act will be on active duty only during times of national emergency, though it will probably be necessary to establish periodic terms of training, so as to better fit the officers for such service. With the passing of the emergency these men will automatically go on the inactive list; always however, subject to call to active duty by the surgeon-general. Detailed plans for the organization, training and assignment of the reserve officers are now under consideration.

MEDICAL journals report that the permanent committee which has been appointed to centralize matters connected with the rehabilitation of disabled soldiers, comprises representatives of all the allied governments. They include Dr. Bourrillon (France), who serves as president of the committee; Dr. Mélis (Belgium), Sir Charles Nicholson (Great Britain), General Bradley (United States), L. March (France), Dr. Da Costa Ferreira (Portugal), and Agathonovitch (Serbia) as vice-presidents. All these hold high military rank. An institute for research has been founded at the headquarters of the committee which is already installed at 102 rue de Bac, Paris. A review is to be issued by the committee. The editor in chief is Dr. Jean Camus, of the Paris Medical School, with Dr. Bourrillon, the president of the committee, and Mr. C. Krug, the secretary general, as the board of directors for the publication. The work of the committee is to include the promulgation of the general principles for rehabilitation of the

disabled, which each country can adapt to its own laws and customs; to group and centralize the data and the lessons learned from experience, and to apply them and aid in every way the mutilated and to extend this aid into the future after the war. By this coordination of efforts each one of the allied peoples will be able to profit by the improvements and achievements realized in any one of them.

The announcement was recently made in the British Parliament by the president of the Board of Agriculture that active steps have been taken with a view to the establishment at Cambridge of an Institute of Agricultural Botany, the primary function of which will be the breeding and distributing of improved varieties of agricultural crops. The plan in question was very fully described by Mr. Lawrence Weaver, of the Board of Agriculture, at a meeting of the Agricultural Seed Association held on July 15. It appears that the new institute will be modelled on the famous Swedish plant-breeding station at Svälof, and that its activities will be to follow two distinct lines, one of which will be purely scientific, while the other will have a commercial outlook. More precisely, the scientific wing will be concerned with the producing of pure cultures of new varieties on the field-plot scale; the economic wing will deal with the growing and distribution on a large scale of these varieties. Presumably, on the Svälof model, the scientific side will oversee the operations of the commercial to the extent of guaranteeing the purity of the stocks distributed by the latter. It is announced that subscriptions towards the establishment of the new institute amounting in the aggregate to upwards of £30,000 have already been received including a sum of £10,000 down and £2,000 a year for five years from a commercial firm and that the Board of Agriculture will provide the necessary buildings and equipment.

The Association of British Chemical Manufacturers has in preparation a directory of British chemical products, and the manufacturers from whom they can be procured. The directory, which will be printed in English, French, Italian, Japanese, Portuguese, Russian and Spanish, is expected to be published before the end of the year.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Andrew Dixon White, Cornell University will receive $160,000 on the death of Mrs. White. It receives many paintings and other objects. Dr. White had already given the university his general and architectural libraries, scientific apparatus, funds for extinguishment of debt, illustrative material and other items, and also his house which cost about $75,000. Yale University, Dr. White's alma mater, receives $5,000 for the endowment of the Andrew Dickson White prizes in history and composition, which were established and have since been maintained by Professor Guy Stanton Ford.

Dr. A. Hoyt Taylor, for nine years professor of physics and head of the department, University of North Dakota, having resigned after a year's leave of absence, to continue his war service as lieutenant commander of Naval Radio Communication, in charge of Atlantic Coast Service, Dr. B. J. Spence, associate professor of physics, has been promoted to a full professorship to be head of the department. Dr. Spence has been at North Dakota for the past eight years. Dr. John W. Cox, professor of pathology and director of the State Public Health Laboratory, University of North Dakota, having resigned to enter the United States Public Health Service, he is succeeded by Dr. Alfred G. Long, of Mankato, Minn., as acting director.

Professor C. L. Dake, of the Missouri School of Mines, has returned to his regular duties, after spending his year's leave of absence as a petroleum geologist.

Alfred E. Day, formerly of the Syrian Protestant College, has been appointed professor of biology in the University of Buffalo.

Dr. Charles Packard, recently instructor in zoology in Columbia University, has arrived in Peking, China, where he will have charge of the work in biology in the Union Medical Col-

lege, the maintenance of which is one of the lines of activity of the Rockefeller Foundation.

DISCUSSION AND CORRESPONDENCE

CONCERTED FLASHING OF FIREFLIES

ON a hot and dark evening in the summer of 1915, a camping party sought the rocks near the waters edge on the north shore of Sloop Bay, Valcour Island, Lake Champlain. An intermittent flashing of diffused light was soon noticed in the northwestern corner of the bay between 300 and 350 meters distant. This flashing was somewhat similar to that ordinarily called "heat-lightning," but as it appeared against the base of a cliff something over ten meters high an investigation of the phenomenon was decided upon.

On approaching in canoes, a scene of wondrous beauty presented itself. The light was due to the minature lamps of several thousands of fireflies which were holding festival over what appeared to be a breeding ground. The area involved was about 100 meters in length and extended from near the water's surface to a height of about seven meters. At this locality the bare rock faultscarp which formed a portion of the north wall of the bay was covered with a steep sloping bank of glacial and postglacial deposits and these were well supplied with water through seepage. Moving southwesterly one left the bare portions of the cliff and rapidly passed through various plant communities from lichens and mosses to a small grove of white pines. Above this locality there was also a forest clearing used as a meadow.

At no time over the limited area at the base of the bank could one notice an utter absence of illumination but the lighting of a small cluster of lamps seemed to awaken immediate response from a thousand others, and the illuminated area thus spread from one or more centers until the bank was brilliantly ablaze and suggestive of the myriad lights of some city of fairyland. It was these periods of intense illumination that had attracted the attention of the camping party at a distance so great that the lights from a few scattered lamps seemed to leave the bank in absolute darkness. The same phenomenon was also observed on the following evening.

After reading Dr. Edward S. Morse's "Fireflies Flashing in Unison"[1] the writer determined to make another visit to this locality and observe the phenomena more critically. On the evenings of July 11 and 12, 1916. the display was repeated and observed by several visitors. It was impossible to count the number of lamps which were aglow at one time, but the space involved was about 700 square meters in cross section and in some bush-covered places there must have been at least 50 fireflies to the square meter. We should judge that about 10,000 of these insects were present. During these visits we noted that the illumination was never due to a truly synchronous lighting of the lamps of those fireflies engaged in the display but was always of the nature of wave motion spreading out from one or more centers. This spreading moved swiftly from one end of the bank to the other and was particularly beautiful when the light from several centers became confluent, for at that instant the whole bank was very brilliantly illuminated. Strictly speaking there was no *measured* regularity in this concerted response and therefore no *true rhythm*, —such as one may note in the concerted music of certain orthoptera. The repititions were hardly more regular than the cloud illuminations of a distant thunderstorm. There was present the influence of suggestion on what may be called a "mob-psychology" but there was *no special leader*. Any small group could excite a discharge from thousands who were ready to respond. As recovery was rapid, the repititions of the wave-like responses were also rapid.

It is probable that the phenomenon is by no means a rare one and that, in this locality, it is repeated yearly—though the display of 1916 was not quite so brilliant as that of 1915. A display in any place would be compellingly attractive to a passing person only if the festival period occurred during very dark, cloudy or moonless nights. The observer

[1] SCIENCE, February 4, 1916.

therefore must happen to be in some lonesome spot without other light, at the proper time of year, under the conditions noted above, and at least after 10 P.M. Even then his observations unless published would not be likely to reach students.

In Science for July 26, Dr. E. S. Morse gives a brief review of the subject,—with reference to its meager literature. There we find mention of such conditions as "very warm and humid" a "profound calm" following a thunderstorm, "a small clearing" and "stumps" or "trees."

The excessive abundance of fireflies at any one date is no doubt due to climatic conditions that have at first retarded and then hastened emergence from the pupa state. The fact that so many of these insects should occasionally be crowded into limited areas may be due to favorable ground conditions involving moisture; open spaces (where the light signal may be seen at a distance); favorable places (trees, bushes, or stumps) for rests from flight;—shelter from winds;—and perhaps the antecedent direction and strength of such winds. The Valcour Island locality seems to fulfill these conditions and in addition has a large sheltered area, the waters of the bay, across which the light may be seen but on which there is no resting place.

Whether or not the flashes occur in strict unison and whether or not the sequence of recurring responses is a measured one, and so strictly rhythmic, are questions which must be answered through more careful observation of the phenomena. Mr. Nylander, quoted by Dr. Morse, says "The flashes were not so regular as an army officer would like to see in regimental drills but were so rhythmic that any one would take note of their action." In other words, the concerted flashes did not recur with measured regularity but the repetitions were frequent enough to attract attention. How loose a meaning in this discussion do we wish to give the word "rhythm"? Dr. Morse quotes Mr. Purssell as stating "To the best of my recollection the illuminated period lasted about two or three seconds and the dark period perhaps twice that long." A space between the beginning of one flash and the next which could vary from six to nine seconds would in no sense be rhythmic and even if the repetitions occurred with regularity, once every six seconds (the shortest time Mr. Purssell's "recollection" allows), the rhythm would be in very slow, "largo" tempo. Note however in Mr. Morse's quotation that the "several thousand insects in each" of two trees "perhaps a hundred feet apart," "flashed in synchronism, first one tree lighting up and then the other." Here we have the element of response which was so marked in the Valcour Island display. In the latter locality there were several trees and bushes on which rested groups which responded to each other and, at close range, the intervals between group flashings were usually but fractions of a second. The brilliant blazing of the whole bank occurred at intervals varying from a few to many seconds in length—hence the similarity, when seen from a distance, to heat lighting.

If it is desired to get a body of men to sing or play together in perfect rhythm they not only must have a leader but must be trained to follow such a leader. Imagine the difficulty of keeping together on "Old Hundred" if the notes were started with an interval so long as six or nine seconds between each. Do these insects inherit a sense of rhythm more perfect than our own?

Would not a more critical observation of one of Mr. Purssell's trees have shown him that one or more leaders started the flash and that the others "fell in" as in applause;—that the lighting of a tree gained at first in brilliancy and that the light also faded away gradually and not at once. At least this is what was noticed in the four different displays on Valcour Island.

We would ask observers to note the conditions resulting in such local congregations of these insects; to note critically whether the flashings are of the nature of exact unisons, or whether they spread out from small centers, first lighted, and so partake of a rapid but wave-like response to an initial stimulus; and to note also if the sequence of the flashings from the same group is one involving equal

time intervals and so strictly rhythmical in character.

GEORGE H. HUDSON

PLATTSBURGH, N. Y.

ALLEGED REDISCOVERY OF THE PASSENGER PIGEON

IN SCIENCE for November 1 is a communication under the caption "Alleged rediscovery of the passenger pigeon," in which the statement is maintained that a flock of this supposedly extinct bird was recently seen in New York state. Among other observations offered in support of the identification, mention is made of "the whistling sound of their wings." During the seventies and early eighties it was my privilege to form an intimate acquaintance with the passenger pigeon, seeing many thousands of them, shooting hundreds of them and finding numerous scattered nests in the vicinity of Minneapolis, Minn. The wings of this bird never "whistled," the sound made in taking flight being a flapping or fluttering noise similar to that made by the tame pigeon. A flock in rapid flight made a rustling or swishing sound as it passed through the air. On the other hand it is a well-known fact that the wings of the mourning dove produce a loud characteristic "whistling sound" as it launches itself into the air and until it gets well under way. Among pigeon hunters in the old days, this was a commonly recognized distinguishing feature between the two species when other means were obscured.

In and about a "buckwheat field" is an ideal place for an assemblage of mourning doves. Passenger pigeons also fed on grains of various kinds, chiefly wheat and oats, but their favorite food was thin-shelled nuts, largely acorns here in the north.

In view of the fact that no reports of the passenger pigeon from experienced ornithologists have been received for a considerable number of years, in spite of persistent search, it would seem as though this bird must be regarded as an extinct species.

THOS. S. ROBERTS

ZOOLOGICAL MUSEUM,
UNIVERSITY OF MINNESOTA,
November 20, 1918

DEMONSTRATIONS OF VISUAL PHENOMENA

PURKINJE EFFECT

IF a color wheel with a reddish and a bluish color be spun in the light of a strong lantern, and then slowly have its plane turned until the incidence of the light is just grazing, the Purkinje effect is at once demonstrated to a class. As the angle of incidence changes from normal to grazing, the intensity of illumination is reduced to zero, and the red becomes invisible. The effect of this is in general to change the apparent color of the disc through a series of very pretty shades.

PERSISTENCE OF VISION

This is easily shown to a class by means of a lantern, with a slide bearing some letters. Instead of imaging the slide on a white surface, the image should be absorbed by black velvet or the image may be formed in an open doorway. Now move a fairly white stick vertically down in the plane of the image. Different portions of the image can then be seen on the stick, and if the stick be moved fast enough, the eye sees the entire image easily.

PAUL F. GAEHR

WELLS COLLEGE

USONO

TO THE EDITOR OF SCIENCE: In connection with the discussion in your columns as to a more specific name for our country than "America," it may be interesting to note that the advocates of the international language, Esperanto, solved this problem so far as they were concerned quite a while ago, by the adoption of the name "Usono." This is the substantive form of the expression US o NA., composed of the initial letters of this nation's full designation. Usona is, in Esperanto, the adjectival form.

In a rather hasty and superficial glance through the back files of Esperanto publications, I find the word used, either in the text or in date lines, titles, etc., in various magazines, books and pamphlets issued in England, France, Germany, Poland, Switzerland,

etc., including America, under different dates running back to April, 1908. That it was in good standing then is shown by its inclusion in a dictionary published in that year. An extended search would no doubt develop a prior appearance.

This is adequate proof that the word Usono, as a designation for these United States, has been in active service for more than ten years, so that to-day Esperantists throughout the world are entirely familiar with the term, which is tantamount to saying that it is already used and understood in every country of any importance upon the globe.

J. D. Hailman

Pittsburgh, Pa.

SCIENTIFIC BOOKS

MILITARY GEOLOGY AND METEOROLOGY

The publication of the little book on "Military Geology and Topography" which has just been issued by the Yale University Press, furnishes a useful reader in the subject for classes of the student army training courses and represents still another change due to the war—the introduction of the geologist as an integral part of a military organization.

The text, which has been prepared under the auspices of the Division of Geology and Geography of the National Research Council, is intended to give, as its title page states, a presentation of certain phases of the subjects as they are related to military purposes, and as such will prove useful in the classes for which it was prepared. It is not a text-book of geology in which the subject-matter is developed genetically as is customary in cultural or technical collegiate courses, but is essentially an empirical résumé of certain geological phenomena for prospective army officers. For example, streams are treated from a hydrographic viewpoint apart from their influence in the development of land forms and the discussion of rocks is free from detailed tables of classification and extended descriptions of igneous rocks.

The manuscript represents the cooperative work of a number of different men, authorities in their respective subjects, under the editorial supervision of Professor Herbert E. Gregory, who were called upon to prepare their respective contributions with utmost expedition in the midst of other distracting duties. Under such circumstances the product is highly creditable to both authors and editor though it is natural to expect evidence of hurried writing, lack of logical coherence, and overlapping of treatment—faults which have been eliminated with greater or less success by the self-sacrificing work of the editor.

The book includes chapters on Rocks and Other Earth Materials, Rock Weathering, Streams, Lakes and Swamps, Water Supply Land Forms, Map Reading, the Military Use of Minerals. It is well printed, indexed and generously illustrated.

On account of differing methods of treatment incident to the aims and composite authorship, teachers who use the book with S. A. T. C. classes, composed of students of widely different training, may find some difficulty in using it as a text-book for class-room work but students and teachers alike will find it very helpful in conjunction with lectures and laboratory exercises and as a compendium of illustrations of how geological and topographic knowledge is serviceable in military activities.

An "Introductory Meteorology" planned with special reference to the needs of the Students' Army Training Units has just been issued under the auspices of the Division of Geology and Geography of the National Research Council. The manuscript was prepared by the staff of the U. S. Weather Bureau and the result is a compact and well-illustrated book of 150 pages. It is extremely elementary in character but appears to lay a satisfactory groundwork for the more advanced work at military camps or elsewhere to which it is designed to lead.

Seven pages are devoted to the sources from which data are to be obtained and the composition of the atmosphere. This is followed by twenty-one pages devoted to the instruments

used for measuring the meteorological elements, and while this is well written, it is a question if the space it occupies could not with advantage be utilized for a somewhat fuller discussion of other topics. The order of development of the subject proceeds from a discussion of temperatures, pressure, evaporation and condensation to a consideration of fogs and clouds. This is followed by a brief and purely descriptive account of mirage, rainbows, halos and coronas, the chapter being labelled Atmospheric Optics. Two chapters are devoted to Atmospheric Circulation followed by what seem to be unduly abbreviated chapters on Forecasting and Climates.

A well-selected list of reference works and the international symbols are given in appendices.

M.

A GREEK TRACT ON INDIVISIBLE LINES

THE development in recent years of the subject of transfinite numbers, of point sets, and theories of the continuum is directing the interest of mathematicians to kindred speculations among the Greeks. Recent historians of Greek mathematics have paid due attention to Zeno's arguments on motion as they are presented in Aristotle's "Physics," but thus far they have given no consideration to a kindred tract included among the works of Aristotle, namely, the "Indivisible Lines" or "De lineis insecabilibus." Perhaps the reason for this omission lies in the fact that the text as edited by Bekker was for the most part unintelligible. More recent collations of manuscripts, and the translation into English with careful annotations made by H. H. Joachim, of Oxford, render the tract of undoubted value in the history of mathematics.[1] It reveals the arguments on the existence and non-existence of indivisible lines, and on the possibility of constructing a line out of points, as well as those exhibiting the interaction between physical speculation about atoms and the philosophy of geometry—arguments as they were presumably presented in the most celebrated academy of the most cultured city of antiquity. Who can doubt that the divergence of views then held and the perplexing paradoxes advanced discouraged Greek mathematicians from openly using in geometry the conceptions of the infinitesimal and the infinite? Euclid was about twenty years younger than Aristotle and no doubt was familiar with the trend of philosophic thought of his time. Rigor in geometry demanded the exclusison of paradox and mysticism. Notwithstanding Euclid's total abstinence from controversial conceptions, it is evident that the infinitesimal, the indivisible and the infinite continued to command the attention of some mathematicians, as well as of philosophers, for more than two thousand years. We need only mention the title of Cavalieri's famous work, "Geometria indivisibilibus continuorum nova quadam ratione promota," 1635.

The Aristotelean "De lineis insecabilibus" contains five arguments current among the Greeks in favor of the existence of indivisibles; these are followed by twenty-six arguments supporting the contrary view, and twenty-four arguments intended to establish the impossibility of composing a line out of points. Some of these proofs are rigorous. Thus, it is argued that, if indivisible lines exist, they must be of equal length; an equilateral triangle each side of which is an indivisible line has an altitude less than the indivisible. If a straight line composed of an odd number of indivisibles is bisected, one of the indivisibles will be divided. The Greek failure to build a satisfactory theory of the linear continuum as composed of points is due to their application of metrical ideas; the addition of points could never yield length. Aristotle's failure to construct a satisfactory continuum by starting with a straight line

[1] The Works of Aristotle translated into English under the editorship of J. A. Smith and W. D. Ross. Part 2: "De lineis insecabilibus," by H. H. Joachim, Oxford, 1908. We have not seen this tract used in any history of Greek mathematics, but H. Vogt referred to it in an article on the origin of the irrational, printed in the *Bibliotheca mathematica*, 3s., Vol. 10, 1909–10, pp. 146, 153.

and postulating unlimited divisibility lay primarily in his rejection of actual infinity and acceptance only of potential infinity.

If it is one of the aims of mathematical history to set forth the successes and failures of leaders of mathematical thought, then the Aristotelean tract, "De lineis insecabilibus," is worthy of the attention of mathematicians.

Florian Cajori

University of California

SPECIAL ARTICLES

JURA-CRETACEOUS STONEWORT AND LIMNEAS, SUPPOSEDLY FROM ARKANSAS

Preserved in the paleontological collections at Stanford University is a large block of white chert containing spore-cases of stonewort, a siliceous freshwater algæ and moulds and casts of *Lymnea ativuncula* and *L. consortis* White,[1] two pondsnails originally described from the Jura-Cretaceous red beds, variously called the Morrison formation or *Atlantasaurus* zone, at Garden Park, eight miles north of Cañon City Colorado.

The matrix consists of white siliceous material made up of compacted spicules of stonewort. The surface is rusty and roughened from exposure but shows no sign of stream attrition. The specimen is accompanied by a note by J. F. Newson, mining engineer and former Stanford professor, stating that it was one of two large blocks unlike any rock in place in the vicinity, picked up on the J. L. Van Winkle ranch, east ½ section 6, township 5 north, range 16 west, near the Arkansas river opposite old Lewisburg, Arkansas.

If Dr. Newson is correct in supposing that no beds of similar rock outcrop nearby it is thought that the material was carried there or perhaps lost by one of the early exploring expeditions returning down the Arkansas river from Colorado. I have hoped to obtain information on the subject from the distribution of siliceous rocks derived from stonewort remains in this region but they appear to be of such rare occurrences as to have escaped notice.

[1] White, C. A., Bull. 29 U. S. Geol. Sur., 1886, p. 20, Pl. IV., Fig. 8–9, *consortis*, 10–11, *ativuncula*.

With the exception of the nutlets the remains of the Estancia stonewort, *Chara estanciana* Hannibal, are desiccated beyond recognition. These resemble the nutlets of the Bear River stonewort, *Chara stantoni* Knowlton,[2] but are nearly round and marked by six encircling spirals.

There are three groups of limneas found in North America, the Abysmal limneas including *Lymnæa* (*Acella*) *haldemani* Binney, the Moss limneas including *Lymnæa* (*Galba*) *truncatula* Müll., *humilis* Say (+ *cubensis* P fr.), *humilis solida* Lea, *obrussa* Say, and *cooperi* Hannibal and the Marsh limneas including *Lymnæa* (*Lymnæa*) *stagnalis* L., *columella* Say, *auricularia* L., *palustus* Müll. and the European *glaber* Müll. The Garden Park limnea, *Lymnæa ativuncula* White, and Cañon City limnea, *Lymnæa consortis* White, belong to the third group.

These species are the oldest true limneas known from North America. *L. accelerata* White of the Morrison beds is perhaps a *Lioplax* or other operculate while *L. nitidula* Meek of the Bear River Cretaceous is a problematic species that has been confused by White[3] with some other Limnea, possibly the Eocene *L. vetusta* Meek.

Harold Hannibal

San Jose, Cal.

[2] Knowlton, F. H., *Bot. Mag.*, XVIII., 1893, p. 141, text fig. 1–3; White, C. A., Bull. 128, U. S. Geol. Sur., 1895, pp. 63, 104, Pl. X., Figs. 14–16.

[3] White, C. A., Bull. 128, U. S. Geol. Sur., 1895, Pl. VI., Figs. 1–2 doubtful, Fig. 3 *nitidula*.

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